Clinical Evaluation of Cancer Diagnosis with 18F-2-Deoxy-2-Fluoro(18F)-D-Glucose: Its Usefulness in Liver and Pancreatic Cancers

IV. 9 Clinical Evaluation of Cancer Diagnosis with ^{18}F-2-Deoxy-2-Fluoro (^{18}F)-D-Glucose: Its Usefulness in Liver and Pancreatic Cancers

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Introduction

2-deoxy-2-fluoro(^{18}F)-D-glucose (^{18}FDG) has been widely used for the quantitative measurement of glucose metabolism in brain and heart.[1,2] Whereas, increased glycolysis of cancer cells has been well documented by Warburg[3] and many investigators. By these reports, ^{18}FDG was suggested to be a good tracer for cancer detection by positron emission tomography. We have made some experimental study and showed that ^{18}FDG had much advantages for cancer detection by positron emission tomography. Especially, intrahepatic cancer could be positively delineated from normal liver.[4] This was not obtained by routinely used ^{67}Ga tumor scintigraphy. We have now clinically examined the feasibility of this cancer diagnostic technic in patients with hepatoma or metastatic liver cancers and pancreatic cancers.

Materials and Methods

^{18}FDG was synthesized by the method developed by Ido et al.[5] The specific activities of ^{18}FDG administered to patients ranged from 5-10 mCi/mg, according to the lapse of time between the end of synthesis and administration. The patients were intravenously injected with 3-10 mCi of ^{18}FDG. Just after injection, serial scanning by every 5 min was performed by positron emission tomography (ECAT-II). After serial scanning, one or two scan for 8-15 min was added in order to obtain a high quality image. F-18 radioactivities in tissues and tumors were expressed as differential absorption ratio (DAR). The DAR is defined as follows:

$$DAR = \frac{\text{Measured activity}(\mu Ci/g)^{\$}}{\text{Injected activity}(\mu Ci) \;/\; \text{Body weight}(g)}$$

$: Count/pixel(ECAT) was converted to μCi/g by a cross calibration factor between ECAT, curimeter and well counter by an assumption that density of tissues were 1.0 g/cm^3.

Results and Discussion

Fig. 1(a) showed a serial positron image in hepatoma case. F-18 radioactivity increased with time in the frontal part of the liver. However, the increase was not so high in the center of right lobe where large low density area was seen by X-ray CT(Fig. 1(b)). This result means that viability of tumor cells in this case was extremely uneven within the low density area by X-ray CT. These information would be useful for therapeutic planning. Fig. 2(a) showed a positron image in a case of pancreatic cancer. Fifty minutes after injection, high radioactivity was seen in the head of pancreas. However, there was no accumulation of activity in the body of pancreas where abnormal tumor could be seen by X-ray CT. This might be caused by radiotherapy. The body of pancreas was irradiated for 30 Gy because of bone metastasis to vertebrae. The data indicated that ^{18}FDG scan might be useful for the evaluation of therapeutic effectiveness such as radiotherapy and chemotherapy. Fig. 3 showed a image of pancreatic cancer with liver metastasis. Very high accumulation of ^{18}FDG was observed in liver metastasis but was not in primary pancreatic cancers. This means that metastatic lesion would be more viable that primary cite. This kind of information could not be obtained in vivo by conventional methods. Fig. 4 showed the changes of DAR as a function of time after ^{18}FDG injection. Increased accumulations of ^{18}FDG were observed in all cases, but degree of increase varied from case to case. Metastatic liver cancer showed higher DAR than that in hepatomas. Well differentiated hepatoma has much glucose-6-phosphatase which is a dephosphorylation enzyme from G-6-P to glucose. Dephosphorylation of ^{18}FDG-6-P to ^{18}FDG might have occured in well differentiated hepatoma. On the other hand, poorly differentiated hepatoma has less enzyme and metastatic liver cancer from other tissue does not have the enzyme. Consequently, it might be probable that we could distinguish well differentiated hepatoma from poorly differentiated hepatoma and metastatic liver cancer by the pattern of ^{18}FDG uptake.

Conclusion

(1) Hepatomas or metastatic liver cancers and pancreatic cancers could be positively delineated by ^{18}FDG scan. This has not been obtained by conventional tumor scintigraphy.
(2) Tumor scan with ^{18}FDG would provide variable informations about licalization of tumor, tumor biability (some biological parameters) and would be useful for the therapeutical planning and the evaluation of therapeutic effectiveness.

References

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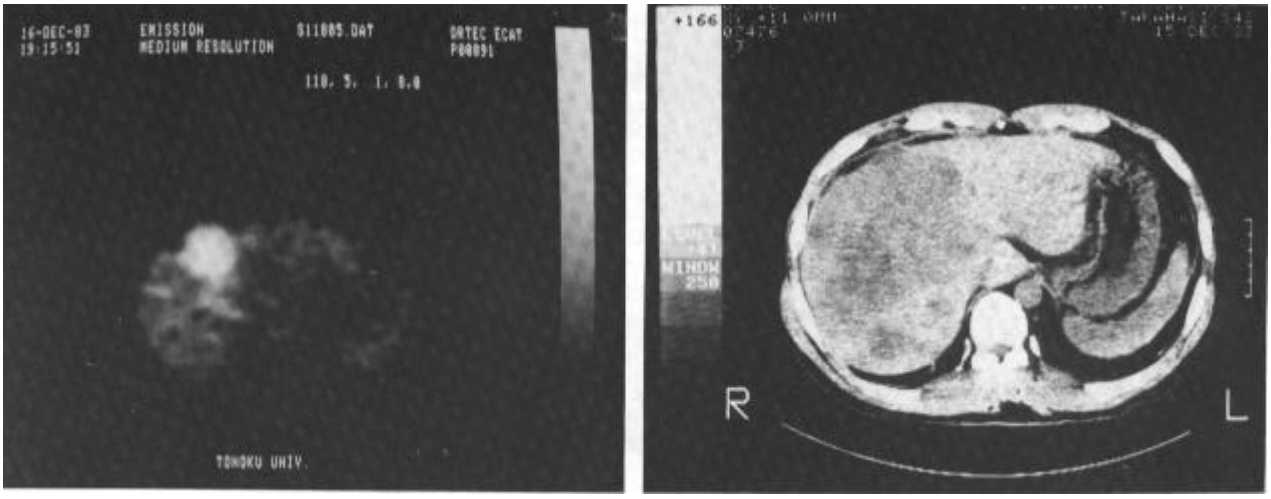

Fig. 1. (a): A positron image of hepatoma with ^{18}FDG (50 min after injection).

(b): X-ray CT of the same scan level as positron image.

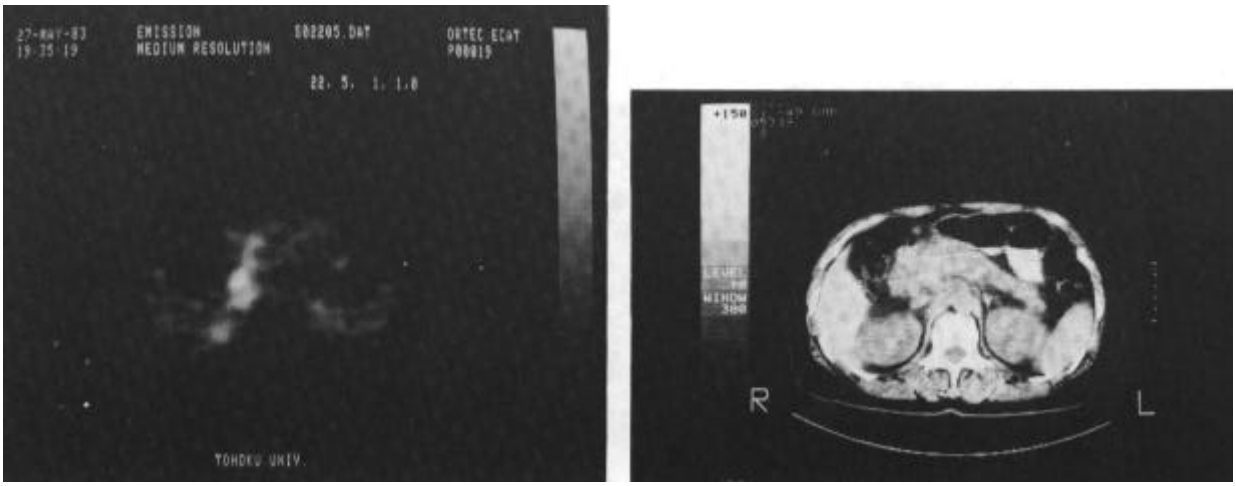

Fig. 2. (a): A positron image of pancreatic cancer (67 min after injection).

(b): X-ray CT of the same scan level as (a).

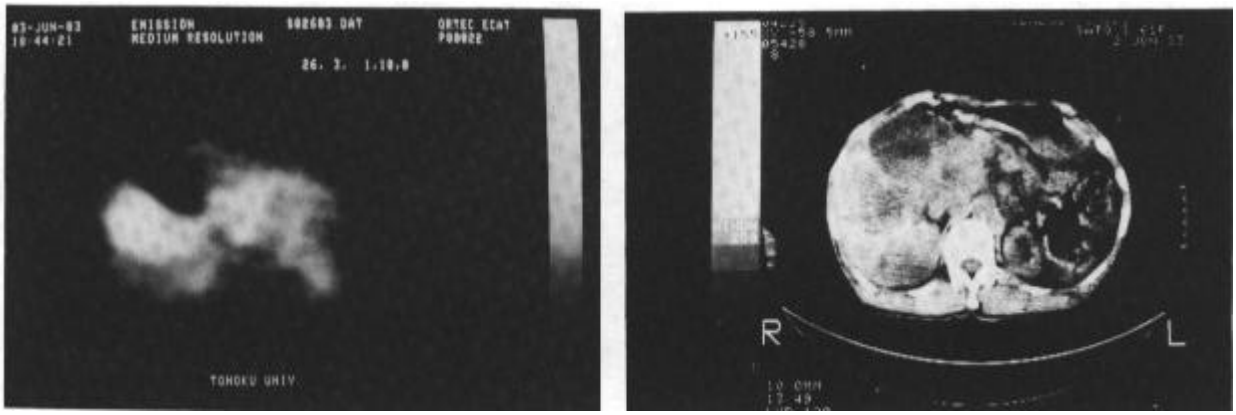

Fig. 3. (a): A positron image of pancreatic cancer with liver metastasis.

(b): X-ray CT of the same scan level as (a).

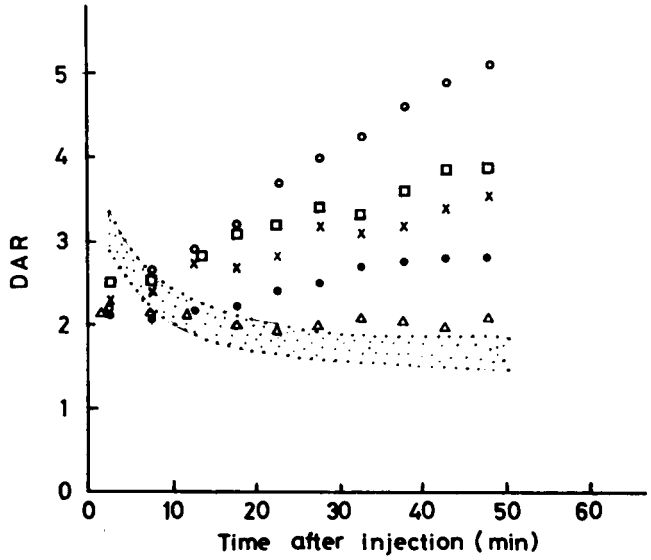

Fig. 4. DAR as a function of time after injection. Increased accumulations were observed in all cases.

o——o, liver metastasis (pancreatic cancer).

□——□, hepatoma.

x——x, pancreatic cancer

●——●, pancreatic cancer

△——△, hepatoma